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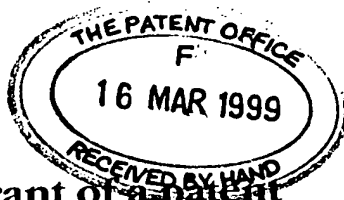
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17MAR99 E433154-1 D02747
P01/7700 0.00 - 9906040.2

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
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1. Your reference

P.Q. 12,856

2. Patent application number

(The Patent Office will fill in this part)

16 MAR 1999

9906040.2

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Central Research Laboratories Limited
Dawley Road
Hayes
Middlesex
UB3 1HH

Patents ADP number (if you know it)

6097943001

If the applicant is a corporate body, give the country/state of its incorporation

England

4. Title of the invention

A CLOSE CIRCUIT TELEVISION (CCTV) SYSTEM

5. Name of your agent (if you have one)

QED I.P. Services Limited

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Dawley Road
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Middlesex
UB3 1HH
England

Patents ADP number (if you know it)

7438609001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)

Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.
- See note (d))

A CLOSE CIRCUIT TELEVISION (CCTV) SYSTEM

5 The present invention relates to close circuit television (CCTV) systems, and more particularly to multi camera CCTV systems.

Multi camera CCTV systems are used increasingly to improve security in a myriad applications, including offices, car parks, shopping malls and on motorways.

10 Such CCTV systems may include tens or even hundreds of cameras. Monitors are installed remote from the cameras and are usually watched by operators in a central control room or monitoring centre.

15 Analogue images obtained by the cameras may be transferred to the monitoring centre by cable which is connected to each camera. The installation of cables may be costly, or may not be practical for some situations where, for instance, only mobile cameras can be used. In such situations CCTV systems send images via a radio frequency (rf) link. Such rf links have limited bandwidth and therefore limit the amount of cameras which may be used in any one system.

20 Large amounts of data are produced from digital cameras. Data compression techniques therefore may be used in wireless (rf) CCTV monitoring systems. However, even these were not able to allow all cameras to transmit at the same time. Therefore operators have had to switch sequentially from one camera to the next in order to monitor
25 premises or check what was happening at a particular location.

A problem has been that sometimes an event has occurred at a location which was not being viewed at the time an event occurred.

30 The present invention arose in an attempt to overcome this problem.

According to a first aspect of the present invention there is provided a Close Circuit Television (CCTV) system including a plurality of CCTV cameras and a communication channel from each of said cameras to at least one monitor; characterised

in that means to obtain information is provided at each camera to obtain information indicative of displacement of an object in the image and processing means is provided to determine whether said information exceeds a predetermined threshold, whereby if said threshold is exceeded an override signal is generated, which override
5 signal switches a monitor to receive from said camera.

The means to obtain information preferably includes a charge coupled device (CCD) and a microprocessor arranged to discriminate pixels or moving portions of an image. Thus one or more cameras are configured/switched automatically to send image data to
10 a monitoring centre when there is an event of interest occurring in viewing field of a camera.

Each camera may be incorporated with a motion or infra red sensor so that images are transmitted only if movement is detected and the camera may be adapted to follow or
15 track a moving object.

Means may also be provided to detect areas of interest. When combined with the invention this enables one or more portions of an image frame to be transmitted, if for example, these areas of interest contain events of interest and there is a risk of a channel
20 reaching its capacity. Thus in the unlikely event of several cameras transmitting data at the same time, a monitor may be adapted to receive images from more than one camera at the same time.

Actuator means for displacing the camera's field of view may be provided. The
25 actuator means may be operated under control of a microprocessor which is arranged to displace a camera so that objects of interest are maintained within a field of view.

Artificial intelligence, for example in the form of a neural network, may be included into the detector.

30

An embodiment of the invention will now be described, by way of example only, and with reference to the Figures.

Figure 1 shows a block diagram of an a camera in accordance with the invention;

Figure 2 shows a block diagram of a moving edge detector which may be incorporated into the camera; and

5 Figure 3 shows a block diagram of a moving object detector.

Electronic control and operating circuitry is shown diagrammatically as 10. Referring to the Figures a camera 2 has a CCD 4 and a lens 6. An actuator 8 is optionally provided.

10

Images from camera 2 are sequential and in digital format. If they are not digital images, an analogue-to-digital converter (ADC) is needed.

Three consecutive frames of sequential video images 11 are stored in three frame stores, 15 FS1 21, FS2 22 and FS3 23. Using the three images a moving edge detector 31 detects moving edges in an image and generates a moving edge image. A reference image 32 containing only background image data is used to compare with sequential images so as to detect whether objects are present in the camera's field of view. The reference image may automatically be adopted whenever there is not an object detected so as to 20 overcome the problem of change of lighting. By comparing a reference image with images from FS2 22, the object detector 33 detects whether or not there are objects present in the images.

Using the information inherent in moving edge images and of objects detected, 25 three features can be detected. These are: events of interest, directions of moving objects and areas of interest. Detection is by way of high level of analysis. Interest Analyser 43 estimates whether there is an event of interest in the field of view. This may be an object/people present or just a static background. From the event of interest detected, decision making means 50 determines when or which images are to be transmitted. Area of interest (AOI) analyser 42 measures an area of interest (AOI) in the image in the 30 region where an event of interest is detected. Thus, only data in AOI 42 is transmitted. Other parts of the image are ignored as they are relatively static and thus bandwidth is saved. By using the technique of block matching, direction analyser 41 detects an

overall direction of movement of the event so that actuator 8 of controls camera 10 to follow the event.

From the three variables: events of interest, directions of moving objects and area of interest, decision making means 50 generates three signals, A, B and C. Signal A is to
 5 inform image buffer 60 to be ready to send an image and which part of the image is to be sent. Signal B requests the transmitter to transfer images by overriding any existing channel. Signal C controls the camera 10 so that it tracks the events of interest if necessary, by tilt, pan or zoom.

10

A moving edge detector is illustrated diagrammatically in Figure 2. Three consecutive images of sequential video images 11 are stored in three frame stores, FS1 21, FS2 22 and FS3 23, and used for moving edge detection. $I_1(x,y)$, $I_2(x,y)$ and $I_3(x,y)$ denote the three consecutive images respectively. The input of Edge Detection 32 is $I_2(x,y)$ and its output is $E_2(x,y)$ which is an edge image from image $I_2(x,y)$. Inputs of temporal difference (1) 31 are $I_1(x,y)$ and $I_2(x,y)$, and output is a difference image $D_{12}(x,y)$ which is defined as the following equation:

$$D_{12}(x,y) = I_2(x,y) - I_1(x,y) \quad (1)$$

20

The inputs of temporal difference (2) 33 are $I_2(x,y)$ and $I_3(x,y)$, and its output is a difference image $D_{23}(x,y)$ which is defined as the follows:

$$D_{23}(x,y) = I_3(x,y) - I_2(x,y) \quad (2)$$

25

The inputs of Multiplication 41 are $D_{12}(x,y)$, $E_2(x,y)$ and $D_{23}(x,y)$ and its output $M(x,y)$ is calculated as the follows:

$$M(x,y) = D_{12}(x,y) \cdot E_2(x,y) \cdot D_{23}(x,y) \quad (3)$$

30

The output of threshold device 42 is the moving edge image $ME(x,y)$ 12, which is defined as follows:

$$\{M(x,y), \text{ if } M(x,y) > T_m \text{ } ME(x,y) \sim 0, \text{ otherwise}$$

where T_m is a threshold for moving edge detection.

(4)

An object detector is illustrated in Figure 3. Frame store FS2 21 contains the input image 11, which is one of the sequential images of camera and may contain objects. Reference Image 22 is a frame store containing a reference image which contains only background image. The reference image may automatically be adopted by input image 11 whenever there is not an object detected in the image. Thus, the problem of changes in light can be overcome. $Q(x, y)$ and $R(x, y)$ denote the image in FS2 and the reference image respectively. By comparing $Q(x, y)$ and $R(x, y)$, the Intensity Subtraction 23 generates a difference image $D(x,y)$, which is calculated as the follows:

$$D(x, Y) \quad Q(x, y) - R(x, y)I \quad (5)$$

Then, using a technique of thresholding, the output $Q(x, y)$ of thresholding means 31 is defined as follows:

$$\begin{aligned} &1, \text{ if } D(x,y) > T, \\ &0, \text{ otherwise} \end{aligned} \quad (6)$$

where I indicates that the pixel is an object pixel, 0 indicates that the pixel is a background pixel, and T threshold for object detection.

Analyser 32, the output signal 12 indicates whether an object or objects have been detected.

The invention has been described by way of example only and variation may be made to the embodiment described without departure from the scope of the invention.

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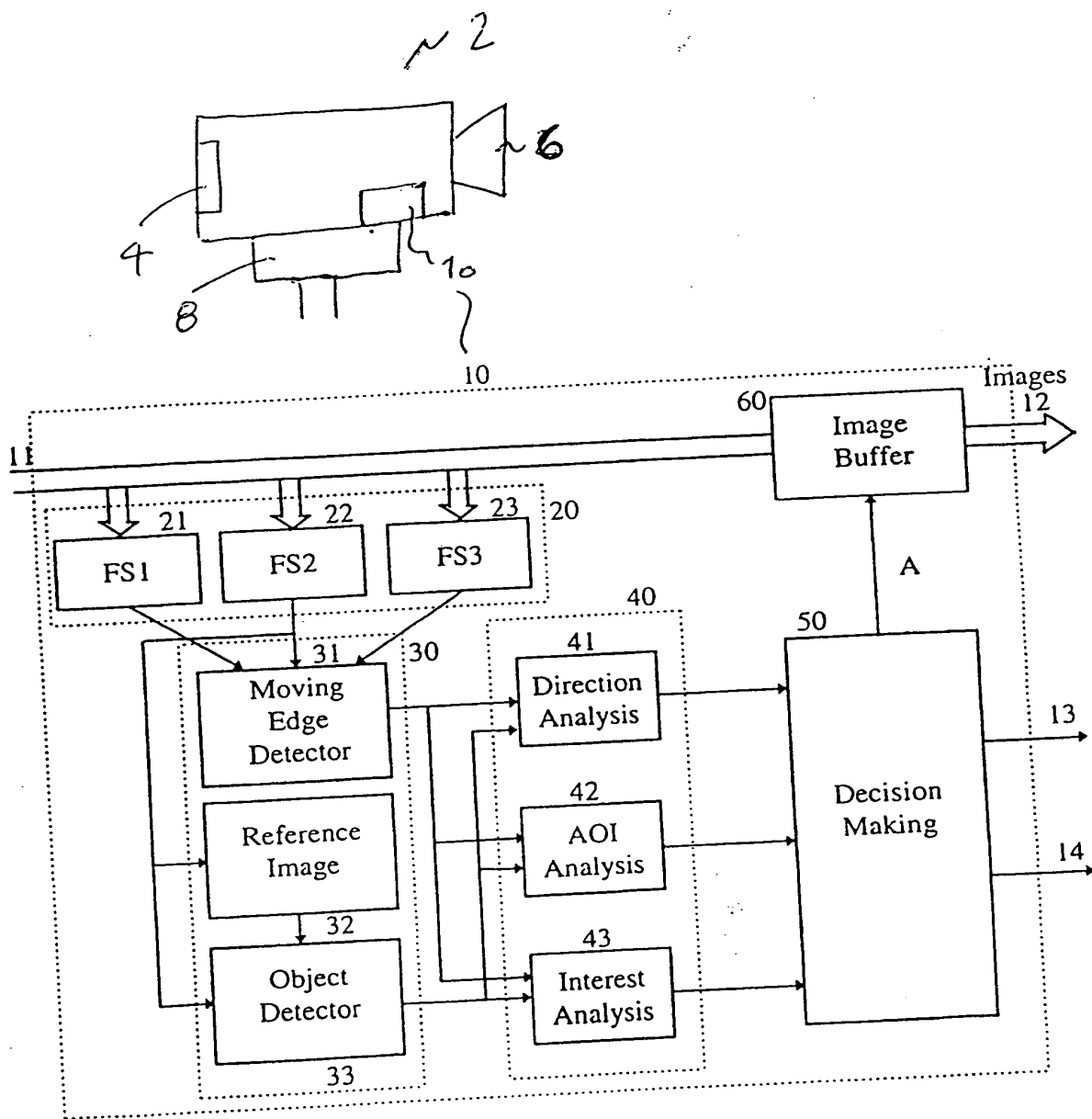


Figure 1: Image processing functionality

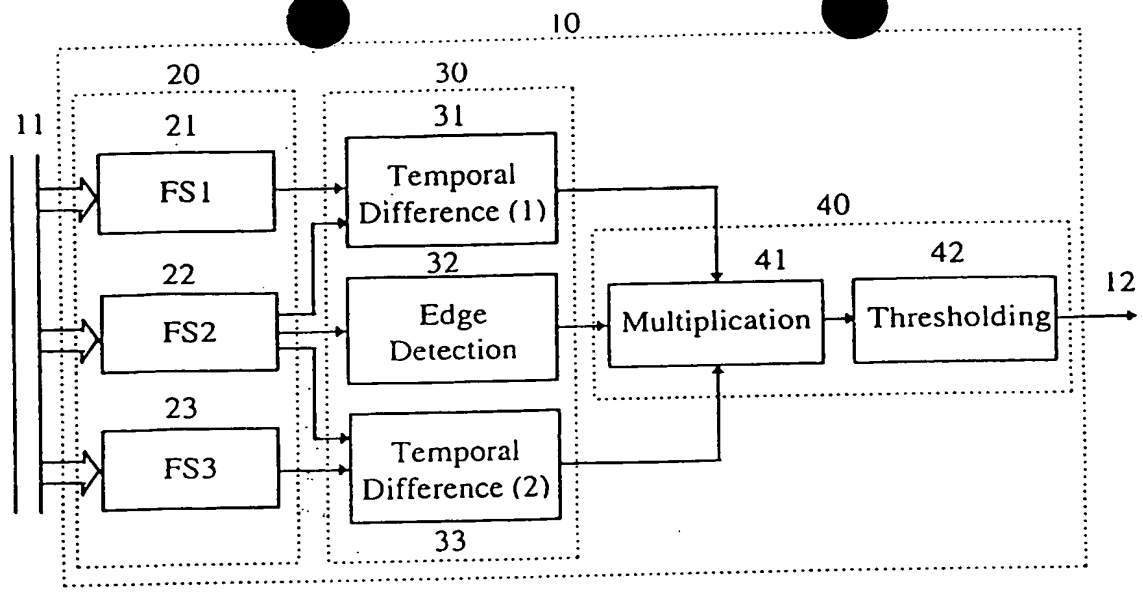


Figure 2. Moving edge detector

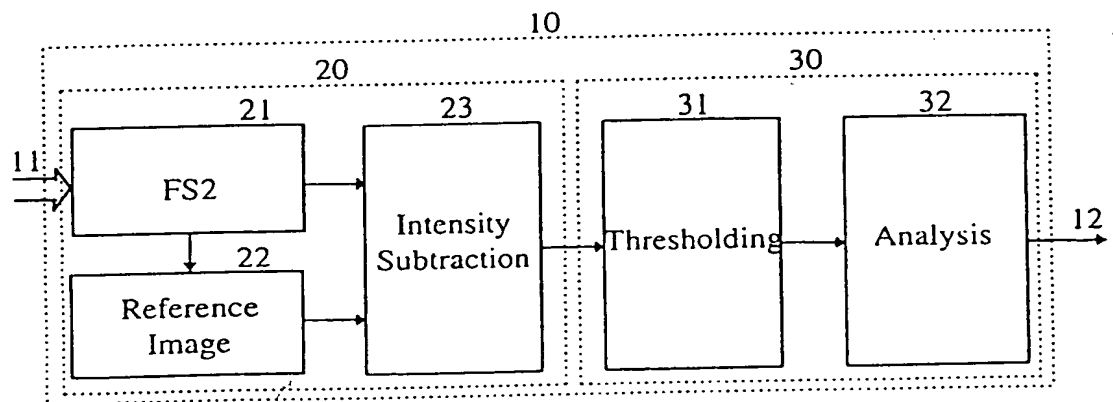


Figure 3: Object detector

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